REMARKS

Claims 1-2, 7, 9, 10, and 12-32 are in the application. Reconsideration and withdrawal of the rejections is requested in view of the amendments to the claims and the following remarks.

Claims 13-18 are allowed. Claims 1 and 19 have been amended to describe forming an aqueous liquid layer on the surface of the wafer. Support for this change is at 0033. Claim 1 has been further amended to associate the etching with the delivery of HF. New claims 27 and 28 are supported at 0033-0035. New claim 29 is supported at 0011-0013, and at 0018, lines 16-17. New claim 31 is supported at 0024. New claim 32 is supported at 0023. No new matter has been added.

Allowed claim 13 has been amended to describe HF, rather than anhydrous HF gas. Claim 13 remains allowable, with this change, at least because of the spraying step. Claim 14 is amended to remain consistent with claim 13.

Applicant advises that Application Serial Nos. 10/917,094 and 10/975,194 have some priority claims in common with this Application, and have pending claims involving use of water, HF and ozone.

Turning to the prior art, Wong, U.S. Patent No. 5,423,944, describes a vapor phase etching process. The HF, water vapor and ozone used in Wong are all in vapor form. Column 1, lines 44-47; column 1, lines 58-60; column 2, line 38; and Fig. 1. In contrast, amended claims 1 and 19 describe forming an aqueous liquid layer on the wafer.

The Wong process is also conducted at low pressure, ranging between 70 torr and by 50 torr. Column 2, lines 61-62. At these reduced pressures, it is difficult to produce an aqueous liquid layer, as claimed. As the Examiner can appreciate, in

Wong, with the chamber at low pressure, any liquid present will more readily vaporize, making it more difficult to produce and maintain a liquid layer under these conditions. The low operating pressures in Wong accordingly teach away from use of an aqueous liquid layer on the wafer.

At page 5 of the November 22, 2004, Office Action, in rejecting claims 7 and 10-11, the Office Action contends that forming a condensate film of HF vapor on the surface of the wafer is inherent in the Wong process. However, a careful reading of Wong reveals that there is no discussion of condensation, or formation of a liquid layer on the wafer. The low pressure conditions suggest a vapor phase process (i.e., the title of the Wong patent), not a liquid process.

Regarding the rejection of claim 19, Zazzera *et al.* describes a study where silicon wafers were treated with anhydrous HF in conjunction with water vapor, to remove silicon native oxide. The wafers are exposed to subsequent rinsing steps, to reduce fluorine concentrations, remove trace metal impurities, and promote initial Si02 formation. UV-ozone exposure reduces the hydrocarbon concentration of the HF-etched surface. In contrast, amended claim 19 describes forming an aqueous liquid layer on a surface of the wafer, for thinning the wafer. Ozone and HF are delivered into the process chamber and move into the liquid layer as a dissolved and/or diffused species from the surrounding gaseous environment. The HF reacts with the Si02 layer and converts it to SiF_4. The role of ozone in Zazzera *et al.* appears to be different from the oxidation role of the ozone in amended claim 19. In addition, in Zazzera, *et al.*, the ozone appears to be consistently used with UV, and not separately as a gas used to oxidize a layer of silicon into Si02.

Regarding the rejection of claims 19-26 at paragraph 5 of the November 22, 2004 Office Action, Ohmi USP 5,944,907 describes purely an immersion process. See column 2, lines 62-63; Fig. 1; column 7, lines 24, 47, and 62; and column 8, line 3.

Verhaverbeke, *et al.*, USP 5,922,624, is a vapor phase process. See column 1, lines 19 and 61; column 2, line 22; and column 4, lines 65. Verhaverbeke *et al.* also discusses generation of water on the wafer surface resulting from the etching of Si02 by HF. However, this is described as a negative result, because the water must be transported away from the wafer surface by evaporation. Column 4, lines 35-40. Specifically, Verhaverbeke *et al.* describes water on the wafer surface as follows:

> "Hence, the water is not easily removed from the surface, giving rise to a strong increase in surface water concentration in the course of the etching process. This results in a fundamental controllability problem of the etching process which is not present with carboxylic acids and especially acidic acid." Column 4, lines 55-61.

Verhaverbeke *et al.* accordingly teaches away from creation of an aqueous liquid layer on the wafer surface, as an element used in wafer thinning as claimed.

In view of the foregoing, it is submitted that the application is in condition for allowance. A Notice of Allowance is requested.

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Respectfully submitted,

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COMPLETE SET OF PENDING CLAIMS:

1. (Currently Amended) A method of thinning [[a]] at least one silicon wafer, comprising the steps of:

placing the wafer into a process chamber;

forming an aqueous liquid layer on a surface of the wafer;

delivering ozone gas into the process chamber to oxidize a layer of silicon on the surface of the wafer; and

delivering HF [[vapor]] into the process chamber [[; and]] , with the HF etching the oxidized silicon layer ~~with the HF vapor~~ to decrease a thickness of the wafer.

2. (Currently Amended) The method of claim 1 wherein the HF ~~vapor~~ is delivered into the process chamber via a carrier gas including ozone.

3-6 (Cancelled).

7. (Original) The method of claim 2 further comprising the step of generating the HF vapor by bubbling the carrier gas through an HF solution contained in a vapor generator.

8. (Cancelled).

9. (Original) The method of claim 1 further comprising the step of generating the HF vapor by mixing anhydrous HF gas with water vapor.

10. (Original) The method of claim 1 further comprising the step of generating the HF vapor by bubbling anhydrous HF gas into water.

11. (Cancelled).

12. (Original) The method of claim 1 further comprising the step of removing the etched oxidized silicon from the process chamber via a system exhaust.

13. (Currently Amended) A method of thinning a silicon wafer, comprising the steps of:

placing the wafer into a process chamber;

delivering ozone gas into the process chamber to oxidize a layer of silicon on the wafer;

delivering ~~anhydrous HF gas~~ <u>HF</u> into the process chamber;

spraying DI water onto a surface of the wafer ~~simultaneously~~ with the ~~step of delivering anhydrous~~ HF ~~gas into the process chamber~~;

dissolving the ~~anhydrous~~ HF ~~gas~~ into the DI water on the wafer surface; and

etching the oxidized silicon layer with the dissolved ~~anhydrous~~ HF ~~gas~~ to decrease a thickness of the wafer.

14. (Currently Amended) The method of claim 13 wherein <u>HF comprises anhydrous HF gas and</u> ~~the ozone gas and~~ the anhydrous HF gas are mixed with one another before being delivered into the process chamber.

15. (Original) The method of claim 13 further comprising the step of forming a microscopic aqueous boundary layer on the surface of the wafer with the DI water.

16. (Original) The method of claim 15 further comprising the step of dissolving the ozone gas into the microscopic aqueous boundary layer.

17. (Original) The method of claim 13 further comprising the step of removing the etched oxidized silicon from the process chamber via a system exhaust.

18. (Original) The method of claim 13 further comprising the step of rinsing the wafer after the etching step is complete.

19. (Currently Amended) A method of thinning a silicon wafer, comprising the steps of:

placing the wafer into a process chamber;

<u>forming an aqueous liquid layer on a surface of the wafer;</u>

delivering ozone gas into the process chamber to oxidize a layer of silicon on the wafer into SiO_2;

delivering HF into the process chamber to react with the SiO_2 layer and convert the SiO_2 layer into SiF_4; and

removing the SiF_4 to thin the wafer.

20. (Original) The method of claim 19 wherein the HF is delivered into the process chamber in vapor form.

21. (Original) The method of claim 20 wherein the HF vapor is delivered into the process chamber via a carrier gas.

22. (Original) The method of claim 21 wherein the carrier gas comprises ozone.

23. (Original) The method of claim 20 wherein the removing step comprises exhausting the SiF_4 in vapor form from the process chamber.

24. (Original) The method of claim 19 wherein the HF is delivered into the process chamber in aqueous form.

25. (Original) The method of claim 24 wherein the removing step comprises dissolving the SiF4 with an aqueous solution.

26. (Original) The method of claim 19 wherein the ozone gas and the HF are mixed with one another before being delivered into the process chamber.

27. (New) The method of claim 1 wherein the aqueous liquid layer is a microscopic layer.

28. (New) The method of claim 1 wherein the aqueous liquid layer is a visible liquid layer.

29. (New) The method of claim 1 wherein the HF comprises a vapor, an aqueous liquid, or an anhydrous gas.

30. (New) The method of claim 1 further comprising the step of spinning the wafer.

31. (New) The method of claim 13 further comprising spinning the wafer.

32. (New) The method of claim 1 wherein a batch of wafers are placed in the process chamber.